

AD-A254 367



2

A Comparison of Measured Relative Transmission Loss with Model Predicted Transmission Loss in the Straits of Sicily

DTIC
ELECTE
AUG 13 1992
S A O

J. K. Fulford
Numerical Modeling Division
Ocean Acoustics and Technology Directorate



Approved for public release; distribution is unlimited. Naval Oceanographic and Atmospheric Research Laboratory, Stennis Space Center, Mississippi 39529-5004.

92-22750



92

ABSTRACT

A comparison of a measured data set with five different model predictions is presented. Three of the predictions use the Low Frequency Bottom Loss model for the area, one prediction uses a geoacoustic model, and one (pure cylindrical spreading) assumes no bottom loss. All five predictions agree with the measured data well, with root-mean-square error under 2.5 dB. The models using bottom loss follow the trend better than cylindrical spreading.

DTIC QUALITY INSPECTED 8

Accession For	
NTIS CRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution /	
Availability	
Dist	
A-1	

ACKNOWLEDGMENTS

The author would like to thank Mr. J.T. Gottwald of G/J Associates for the experimental data . Tasking support was provided by Mr. Bob Davis, Program Manager with the Air ASW Assault and Special Mission Programs Office (PMA 264) under Program Element 0603254N.

CONTENTS

INTRODUCTION	1
DATA DESCRIPTION	1
GEOACOUSTIC MODEL	5
RESULTS OF MODELING	6
CONCLUSIONS	8
REFERENCES	8

A COMPARISON OF MEASURED RELATIVE TRANSMISSION LOSS WITH MODEL PREDICTED TRANSMISSION LOSS IN THE STRAITS OF SICILY

INTRODUCTION

The purpose of this technical note is to report the results of comparing transmission loss predictions from a number of models using the Navy standard Low Frequency Bottom Loss Model (LFBL) with a prediction made using a geoacoustic based model of bottom loss against a measured data set. The transmission loss data used for the comparisons was taken by the Naval Air Warfare Center Aircraft Division (NAWCAD) in the Straits of Sicily as part of the ASW Environmental Acoustic Support (AEAS) harsh environment program. The data consists of relative transmission loss (relative to the loss at 2 nmi) along a single radial.

DATA DESCRIPTION

The acoustic and environmental used (with the exception of the geoacoustic information) in this study was collected, or assembled by NAWCAD (1992) as part of the AEAS harsh environment program. The acoustic data was reported as relative transmission loss; thus, the shape of the relevant environmental parameters will be paramount rather than the absolute values. The reduced data was then simulated by NAWCAD using the Navy standard passive Raymode model (Leiberger, 1971), and the NAWCAD Bistatic Active Model (BAM) as described by Bartberger (1991).

The data was collected using 60 ft denotation depth Mark 64 SUS charges as sources and padded AN/SSQ 57 omnidirectional sonobuoys deployed at 400 ft as receivers, the frequency band used spanned 175 to 625 Hz. The receiver were spaced every 2 nmi along an east-west track beginning at approximately 34° 55' North by 14° 27' East.

The environment was assumed to be range-independent (Fig. 1 shows the measured sound speed profile down to the assumed depth of the water sediment interface), with the bottom loss described using LFBL as indicated in Figure 2. Examination of the sound speed profile reveals that it is virtually isovelocity, with a variation of 7 ft/s over 1200 ft. The source (at 60 ft depth) has a sound velocity 4 ft/s less that is observed by the receiver, which is at the sound speed maxima. The small difference gives rise to a weak surface duct; thus, surface duct propagation should be unimportant in the predictions.

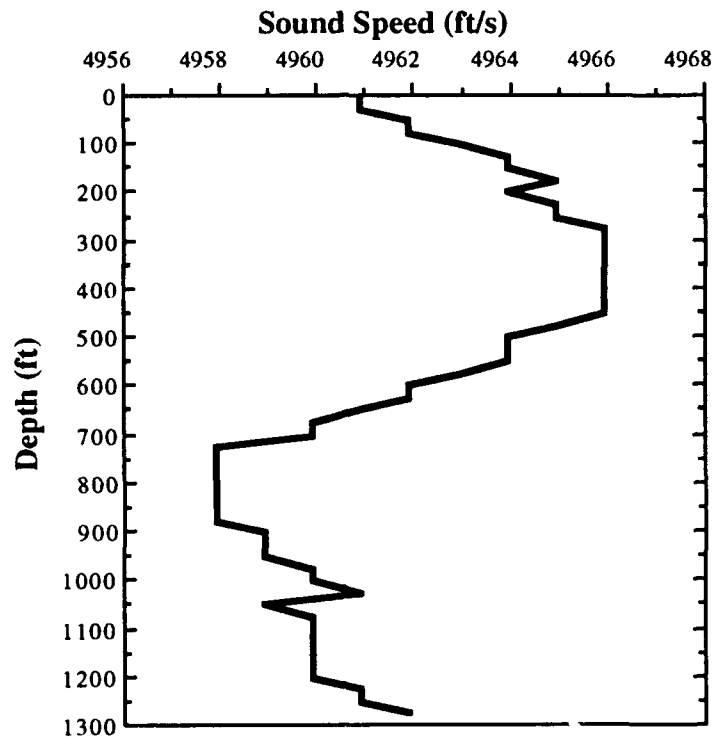


Figure 1. Plot of measured sound speed versus depth.

The transmission loss data for the frequency band 175 to 625 Hz (relative to the loss at 2-nmi range) is illustrated in Figure 3 where the transmission loss for cylindrical spreading has been added for reference. The measured transmission loss shows two features that depart from that expected from a range-independent area. First the relative loss is lower than expected at 4-nmi range, and there is a suggestion of structure at approximately 12-nmi range. The two deviations away from cylindrical spreading can be explained by the bathymetry illustrated in Figure 4. Initially the propagation is downslope, which causes the bottom bounce energy to arrive at the receiver depth at longer ranges than the flat bottom case, then the bottom slopes up, which causes a second (or later) bottom bounce to arrive at shorter ranges than would be expected.

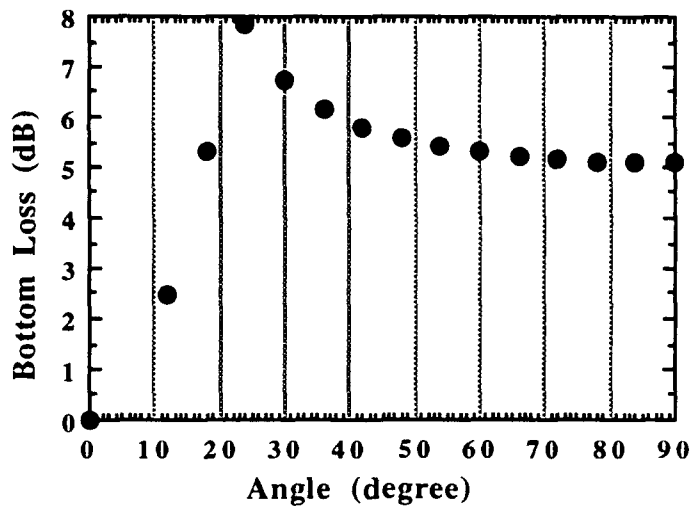


Figure 2. Scatter plot of bottom loss versus grazing angle (derived from LFBL) for the measurement area.

Despite the difference between the modeled bathymetry and the actual bathymetry, it should be noted that the cylindrical spreading model prediction has root-mean-square error of 1.6 dB relative to the measured data (if the data at 2 nmi is included). This suggests that the propagation models using range-independent environments should do reasonably well.

That is, the dominate energy paths suffer little loss through interaction with the bottom. Examination of the sound speed profile suggests that paths that interact with the receiver (at the global sound speed maximum at 400 ft) will interact with the bottom, thus bottom interaction must be considered. The bottom loss curve presented in Figure 2 suggests that there is a small region where bottom interaction can occur with low bottom loss.

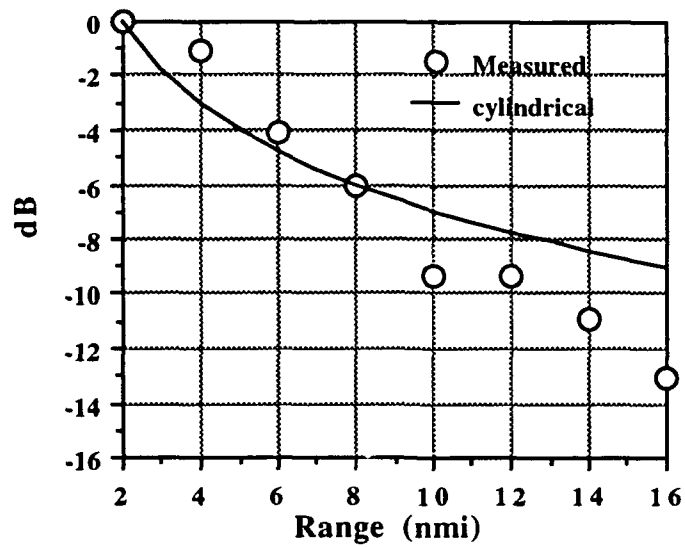


Figure 3. Comparison plot of measured transmission loss (relative to 2 nmi) versus range and cylindrical spreading.

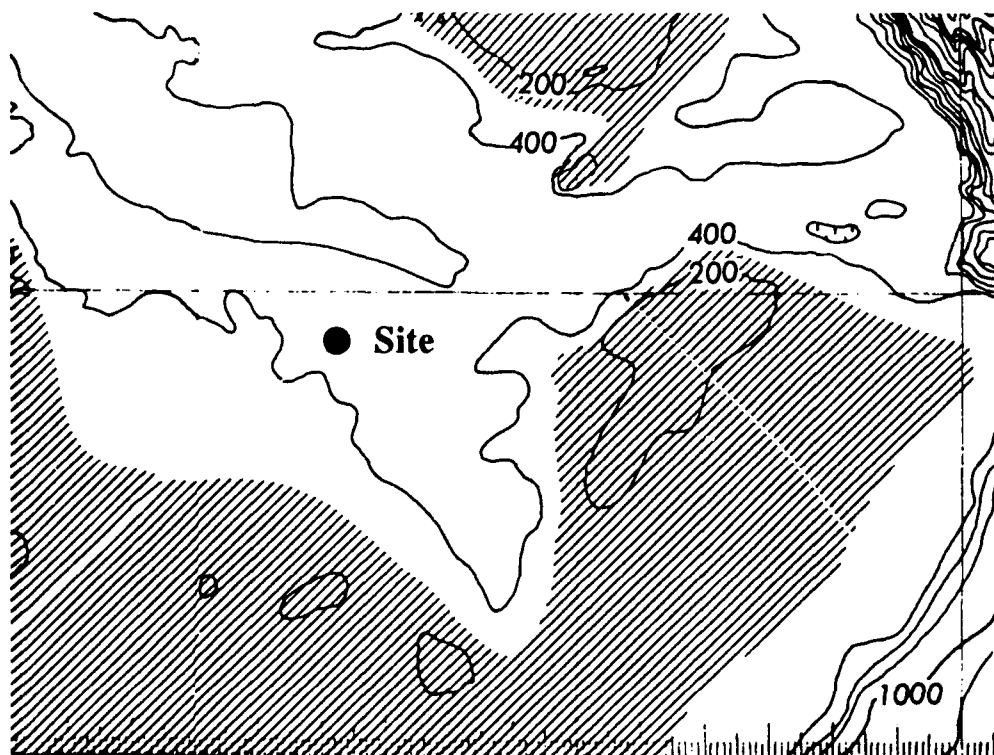


Figure 4. Schematic map of the exercise area.

GEOACOUSTIC MODEL

For comparison with the bottom loss indicated by LFBL a geoacoustic model of the sedimentary material generated by Matthews (1982) has been converted to bottom loss versus grazing angle table using the Reflec model, a Naval Research Laboratory program based on the Thompson-Haskill matrix approach (Brekhovishikh, 1960). Table 1 lists the geoacoustic model, and Figure 5 shows a comparison of the geoacoustic generated bottom loss with LFBL generated bottom loss. Although an insufficient sample of the LFBL curve is presented, the structure of the low grazing angle part of the bottom loss curves is similar, and suggests that the predicted transmission loss will be similar.

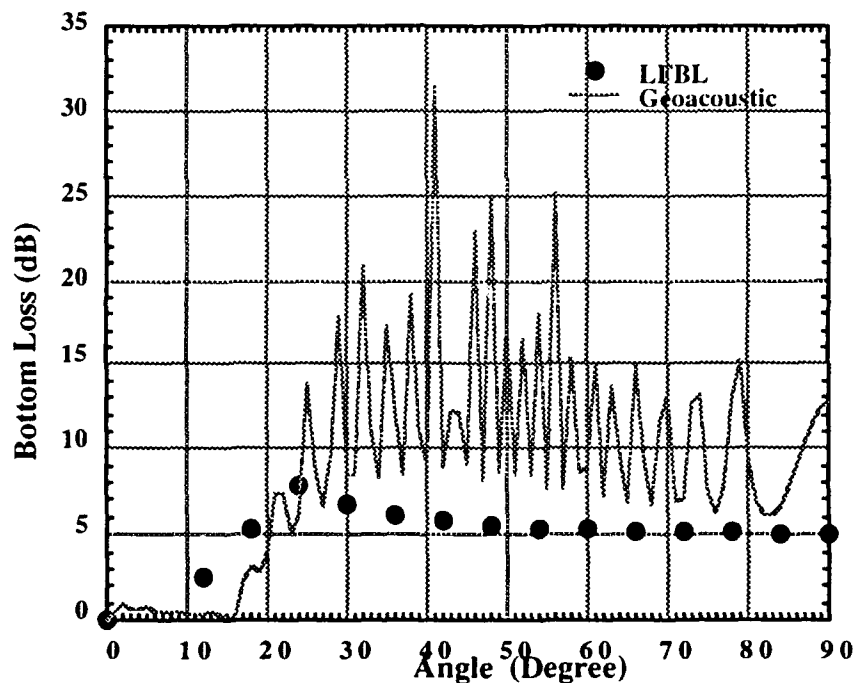


Figure 5. Plot showing comparison of geoacoustic model generated bottom loss curve versus LFBL generated bottom loss curve.

Table 1. Geoacoustic model of the Straits of Sicily (Matthews, 1982).

Depth (meters)	Compression speed (m/s)	Shear speed (m/s)	Compression attenuation dB/m/kHz	Shear attenuation dB/m/kHz	Density (g/cc)
0	1502	116	.0045	15.0	1.52
25	1534	232	.0060	20.0	1.55
75	1552	301	.0075	25.0	1.57
50	1596	333	.0090	30.0	1.62
100	1625	365	.0110	36.7	1.65
125	1653	395	.0120	40.0	1.69
150	1680	409	.0130	43.3	1.72
175	1706	424	.0140	46.7	1.75
200	1731	438	.0150	50.0	1.78
250	1778	467	.0170	56.7	1.83
300	1820	495	.0190	63.3	1.88
350	1857	525	.0195	65.0	1.92
400	1889	554	.0190	65.3	1.95
500	1937	612	.0160	53.3	2.01

RESULTS OF MODELING

Figure 6 shows a plot of the measured data and predicted results from cylindrical spreading without absorption loss, Raymode, BAM, ADAM using LFBL based bottom loss, and ADAM using a geoacoustic based bottom loss. For each model the transmission loss has been set to 0 at 2 nmi; thus, the comparisons are of relative transmission loss. Interpretation of the plot suggest that each of the models performs adequately, the differences between the models and the data seem to be largely caused by unresolved bathymetric effects. The comparisons further show, in relative terms, that LFBL and geoacoustic based bottom loss curves give rise to similar transmission loss curves.

Table 2 lists the values used in producing Figure 6. Note that the root-mean-square value of the absolute error is less than 2.5 dB for each of the models. Given the few data points available for this comparison, it is not possible to conclude that one model is better than another, nor that the geoacoustic model is better than LFBL in this area for transmission loss. It should be noted that while cylindrical spreading predicts the data well from a statistical point of view, the models using bottom loss present results that follow the trend of the data more precisely.

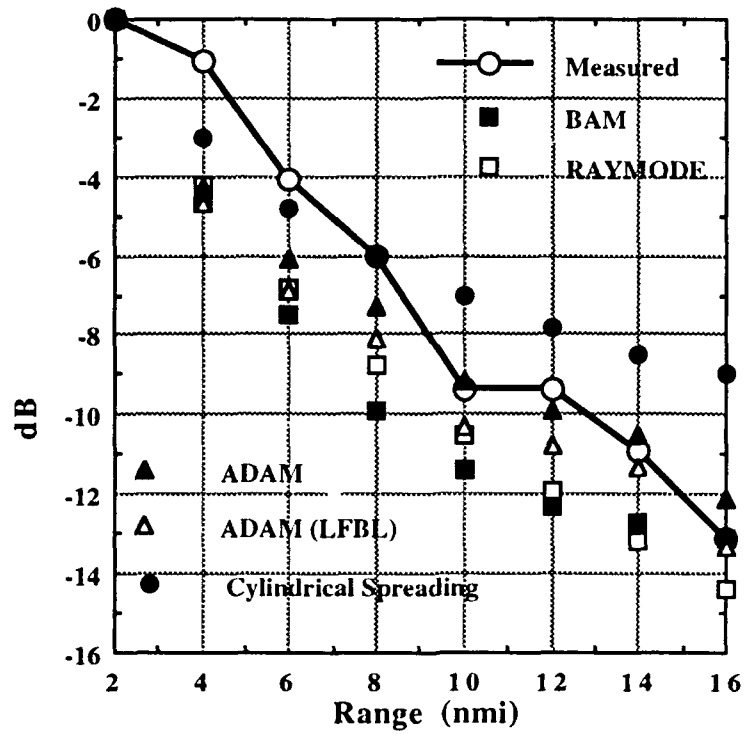


Figure 6. Plot of measured relative transmission loss versus model outputs.

Table 2. Relative transmission (dB) relative to transmission loss at 2 nmi for the data and models.

Measured	Cylindrical	Raymode	BAM	ADAM LFBL	ADAM geoacoustic
0.0	0.0	0.0	0.0	0.0	0.0
1.1	3.0	4.2	4.6	4.7	4.3
4.1	4.8	6.8	7.5	6.9	6.1
6.0	6.0	8.8	9.9	8.1	7.3
9.4	7.0	10.5	11.4	10.3	9.2
9.4	7.8	11.9	12.3	10.8	9.9
10.9	8.5	13.2	12.7	11.3	10.5
13.1	9.0	14.4	13.1	13.3	12.1
RMS error	1.9	2.3	2.5	1.5	1.2

CONCLUSIONS

For the limited relative loss data set, within the context of range independent bathymetry, each of the four models cylindrical spreading, Raymode, BAM, and ADAM performed well. Statistically there was no difference between the performance of the ADAM model using LFBL based bottom loss, and a geoacoustic based bottom loss, although the models using bottom loss followed the trend of the data better than cylindrical spreading alone.

REFERENCES

Bartberger, Charles (1991). Physics of the Bistatic Active Model (BAM). Naval Air Development Center, Warminster, PA. NADC Report 9102050.

Berkhovishikh, J.M. (1960). Waves in Layered Media. Academic Press, New York pp. 15-59.

Leiberger, G.A. (1971). A Combined Ray Theory-Normal Mode Approach to Long Range, Low Frequency Propagation Loss Prediction. Naval Underwater Sound Center, New London CT, NUSC Technical Memorandum PA3 0109 71.

Matthews, J.E.(1982). Geoacoustic Models for the Straits of Sicily and Sardina-Tunisia. Naval Ocean Research and Development Activity, NSTL, MS, NORDA Technical Note 99.

NAWDAD (1992). Unpublished Manuscript.

DISTRIBUTION LIST

Program Executive Officer, PMA 264
Air ASW Assault & Special Missions Programs
Code 264G
Washington, DC 20361-1264
Mr. Bob Davis

Naval Research Laboratory
Washington, DC 20375-5000
Dr. David Fromm (Code 5160)
Library (2)

Naval Surface Weapons Center Dahlgren Division Detachment White Oak
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000
Dr. George Gray

Naval Command Control and Ocean Surveillance Center RDT&E Division
Code 541
San Diego, CA 92152-5000
Dr. Homer Bucker
Mr. Newell Booth

Office of Naval Research Detachment
AEAS Office
Stennis Space Center, MS 39529-5004
Mr. Edward Chaika

Naval Air Warfare Center Aircraft Division Warminster
Code 5044
Warminster, PA 18974-5000
Mr. Tom Gabrielson
Mr. Anthony Brescia

Naval Research Laboratory Detachment

Stennis Space Center, MS 39529-5004

Code 125L (10)

Code 125P

Code 200

Code 220

Code 223

Code 240

G/J Associates

968 Yachtsman Way

Annapolis, MD 21403

Mr. Jim Gottwald

Naval Oceanographic Office

Stennis Space Center, MS 39522-5001

Code TD

Library (2)

REPORT DOCUMENTATION PAGE

Form Approved
OBM No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. Agency Use Only (Leave blank).

2. Report Date.
July 1992

3. Report Type and Dates Covered.
Final

4. Title and Subtitle.

A Comparison of Measured Relative Transmission Loss with Model Predicted
Transmission Loss in the Straits of Sicily

5. Funding Numbers.

Program Element No. 0603254N

Project No. H1292

Task No. 000

Accession No. DN252105

Work Unit No. 92232C

6. Author(s).

J. K. Fulford

7. Performing Organization Name(s) and Address(es).

Naval Oceanographic and Atmospheric Research Laboratory
Ocean Acoustics and Technology Directorate
Stennis Space Center, MS 39529-5004

8. Performing Organization
Report Number.

NOARL Technical Note 287

9. Sponsoring/Monitoring Agency Name(s) and Address(es).

Naval Air Systems Command
Air ASW Assault and Special Missions Programs
Washington, DC 20361-1264

10. Sponsoring/Monitoring Agency
Report Number.

NOARL Technical Note 287

11. Supplementary Notes.

12a. Distribution/Availability Statement.

Approved for public release; distribution is unlimited.

12b. Distribution Code.

13. Abstract (Maximum 200 words).

A comparison of a measured data set with five different model predictions is presented. Three of the predictions use the Low Frequency Bottom Loss model for the area, one prediction uses a geoacoustic model, and one (pure cylindrical spreading) assumes no bottom loss. All five predictions agree with the measured data well, with root-mean-square error under 2.5 dB. The models using bottom loss follow the trend better than cylindrical spreading.

14. Subject Terms.

Acoustic, ASW, Reverberation, Active, Oceanography, Modeling

15. Number of Pages.

11

16. Price Code.

17. Security Classification
of Report.

Unclassified

18. Security Classification
of This Page.

Unclassified

19. Security Classification
of Abstract.

Unclassified

20. Limitation of Abstract.

SAR